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CACHE CREEK ENVIRONMENTAL RESTORATION PROGRAM

Yolo County, California

Cache Creek Document #211

ZENTNER ZENTNER

ZENTNER and ZENTNER

925 Ygnacio Valley Rd.

Suite 250

Walnut Creek

California 94596

Fax: 510.947.1798

Tel: 510.947.6888

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Zentner & Zentner

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Land Planning and Restoration

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Executive Summary

CACHE CREEK ENVIRONMENTAL RESTORATION PROGRAM

MINING REACH SEGMENT

EXECUTIVE SUMMARY

Purpose

This restoration program was prepared to assist in the restoration of the Cache Creek riparian corridor. It reviews the historic and current conditions of this system and proposes specific restoration activities in that portion of the Creek historically subject to aggregate mining.

Setting

Much of the value of riparian systems is derived from the flow of water through a vegetated channel. Cache Creek historically provided significant riparian values for groundwater recharge, erosion control, water quality improvement and wildlife habitat. Today, the Cache Creek riparian system often has low to moderate values resulting from the near absence of riparian habitats and the low habitat diversity. These conditions are especially observable within the approximately 10-mile stretch of Creek known as the "mining reach". Existing conditions in the mining reach, *i.e.*, the deep trapezoidal contours and the lack of riparian woodlands and marshes, do provide for the reduction of flood hazards in this reach (an important local value) and for the deposition of the heaviest sediments in the same area, thereby providing easy access for continued mining. However, these same conditions increase flooding downstream, promote the movement of fine sediment into the settling basin (where it reduces basin capacity and further exacerbates flood heights), encourage bank erosion and significantly limit the habitat value. Furthermore, because riparian values both up- and downstream of this reach are higher, the mining reach is a significant "weak link" in the entire Creek system.

The Restoration Program

The creek system does have significant restoration potential as reflected in the historic values. This restoration program has identified the restoration of riparian woodlands near the Creek as an important goal. Restoration of already mined basins near the Creek represents a relatively inexpensive and potentially significant first step in restoration of the mining reach. In turn, even limited restoration of the mining reach has important benefits for the entire Creek.

Restoration of the mined basins would proceed through minor regrading of the basins, planting with native species, and the use of an existing system of irrigation canals to route winter and spring flows into the basins. The water would support a diverse mix of riparian woodlands and seasonal marshes while also recharging groundwater aquifers. As the aquifers are recharged, regional groundwater levels should rise, allowing development of a native riparian system throughout much of the Creek corridor.

Chapter 1
Introduction

A. PURPOSE

This restoration program was prepared to summarize the assessments, plans, and goals of a wide range of individuals and groups who have worked towards the restoration of Cache Creek for many decades. This program reviews the historic and current conditions of the Creek and focuses on the mining reach for the initial restoration work.

B. SETTING

The Cache Creek watershed occupies an area of 1,150 square miles. About 572 square miles of this basin drain into Clear Lake. Below Clear Lake, Cache Creek descends through a canyon to a narrow alluvial valley that broadens near Capay (Figure One). Downstream from Capay, the gradient continues to decline, from Capay to Yolo, with an intervening section which steepens slightly where bedrock now crops out in the streambed.

Most of the sediment carried by Cache Creek is deposited within the 14.5-mile-long "mining reach" between Capay and Yolo. This reach is the location of braiding and channel shifting and has also been the site of gravel extraction since at least the 1930s (Environ, 1980). Construction of a diversion dam near Capay and subsequent irrigation diversions in 1912 caused the streambed to be seasonally dry and promoted farming of the adjacent terrace lands.

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Regional Location Map

FIGURE 1

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Regional Location Map

FIGURE 1

Although deepening of the creek channel occurred during the period of sand and gravel extraction, net widening of the stream channel is not apparent. Woodward-Clyde Consultants (1976) compared the areas of active erosion and deposition on aerial photographs from 1939 and 1972 and documented a decrease of 73 acres in the area of active streambed, indicating a net narrowing of the channel. Dames & Moore (1991) noted the same trends for the period between 1962 and 1988 and concluded that, over the past decades, the creek has become straighter (with less in-channel meanders) and more uniform, i.e., the sides and bottom of the channel have fewer surface irregularities.

These changes are likely the result of mining confined to a specific trapezoidal shape by the 1972 Interim Ordinance. A channel shape of this sort reduces off-creek flooding in the reconfigured portion but tends to increase downstream flood velocities, reduce sediment deposition, and increase erosion (Williams and Swanson, 1988).

C. CACHE CREEK REACHES

Cache Creek can be divided into four reaches of approximately equal length. They are:

1. The Coast Range Reach

The Coast Range reach of Cache Creek originates in the northern Coast Range at the outlet of Clear Lake. The creek first flows across a Quaternary volcanic flow that forms a natural dam at the southeastern edge of the lake and then, respectively, crosses Paleocene, Cretaceous, and Plio-Pleistocene sedimentary rocks (CDMG 1977) amid low hills. East of Wilson Valley, a small floored depression in these hills, the creek cuts a series of deep gorges through

vertical ridges formed by upturned sandstone sediments of the Cretaceous Great Valley Formation. Little Blue Ridge, Cache Creek Ridge, Cortina Ridge, and Blue Ridge are some of the named features adjacent to Cache Creek in this area. Bear Creek, a significant tributary which enters Cache Creek in the eastern part of this reach, is partially saline as a result of salts derived from the marine Great Valley Formation it drains. This contributes high boron and chloride levels to Cache Creek which are observable downstream.

2. The Capay Valley Reach

Cache Creek leaves the ridgelands in northwestern Yolo County and then flows southeastward through the Capay Valley, a Quaternary alluvium-floored satellite of the Sacramento Valley. The two valleys are separated by the Capay Hills. The coalesced alluvial fans of tributary creeks draining Blue Ridge to the west restrict Cache Creek to the eastern side of Capay Valley. Cache Creek exits Capay Valley and enters the Sacramento Valley by a gorge cut through the Capay Hills at a contact between the Upper Cretaceous sediments of the main hills and the Plio-Pleistocene sediments of Sugarloaf, their southern satellite (CDMG 1977). This gorge is evidence that Cache Creek is older than the uplift which created the Capay Hills.

3. The Hungry Hollow Reach

East of the Capay Hills, Cache Creek crosses Hungry Hollow, a broad depression floored by Quaternary alluvium it has deposited. The hollow is separated from the main part of the Sacramento Valley by the Dunnagin Hills uplift. The creek's alluvial fan, relatively narrow in this reach, is little more than a wide pair of natural levees sloping downward to the north and south into local basins (USDA 1972). Quaternary alluvial gravel deposits under a veneer of loam permit both gravel mining and farming in this reach, which includes the survey area. Cache Creek usually has significant perennial flow in both the Coast Range and Capay Valley reaches even during drought years, but Capay Dam, at the head of the Hungry Hollow reach, diverts almost all of it for irrigation. Consequently the remainder of the creek is dry except immediately following significant rains.

4. The Woodland Reach

Cache Creek's alluvial fan broadens significantly after it passes through the Dunnagin Hills, a low Sacramento Valley tectonic uplift where Plio-Pleistocene sediments are exposed, but otherwise it is geologically similar to the Hungry Hollow Reach. The creek flows just north of the city of Woodland in this reach as it passes more farms and gravel mines. A few miles east of Woodland, Cache Creek ends at a settling basin adjacent to the Yolo Bypass, a large basin which parallels the Sacramento River to its east.

Chapter 2
Historic Conditions

A. PRE-EUROPEAN HABITAT ASSOCIATIONS

The hills and mountains of the Coast Ranges in this region are dominated by blue-oak and digger pine associations, reflecting the generally well-drained substrate and dry climate, with chaparral dominating serpentine and other highly mineralized substrates. In pre-European times the Capay Valley and the west edge of the Sacramento Valley would have been predominantly grassland on the drier soils in the native state, with valley oak woodland in areas where groundwater consistently occurred at 10 to 20 feet below the surface (Figure 2).

Narrow swaths of riparian habitats (including active stream courses, adjacent wash floodplains, riparian woodland, patches of marsh, and an envelope of valley oak woodland) would have followed the streams through the surrounding grasslands. And, in the low elevation areas where the streams emptied and where annual flood-waters accumulated, would have been large marshlands dominated by tules, cattails and sedges. The streams themselves were subject to high flows during the wet season, and would draw down to a trickle or even dry completely during the summer. Each winter, the rain swollen streams would have moved substantial sediment from the upper watershed to the valleys, causing annual meandering of the stream courses.

Scattered through the grasslands would have been a series of small meandering seasonal water channels, and isolated small basins which would have supported a wide spectrum of localized habitats including seasonally wet meadows, seasonal marsh, perennial marsh, and vernal pools depending on variations in hydrology and soils. On the upland areas, variations of the "grassland" vegetation would have been determined by vagaries of soils texture, drainage, and chemistry, supporting such 'types' as wildflower fields, mesic grasslands and dry grasslands.

The soils and hydrology of these habitats can be ranged on a gradient from coarse soils with frequent flooding to fine soils with infrequent flooding, which also approximately reflects increasing distance from water courses and increasing depth to groundwater (Figure 3). Typically, a creek bottom or "wash" would

contain very coarse soils and be subject to frequent flooding; adjacent lands with riparian woodlands would contain medium textured soils and be subject to at least annual flooding; higher ground dominated by valley oaks would contain medium to fine soils and be subject to occasional flooding; and the highest grounds, dominated by grasslands, would contain medium to fine soils and be subject to infrequent to rare flooding.

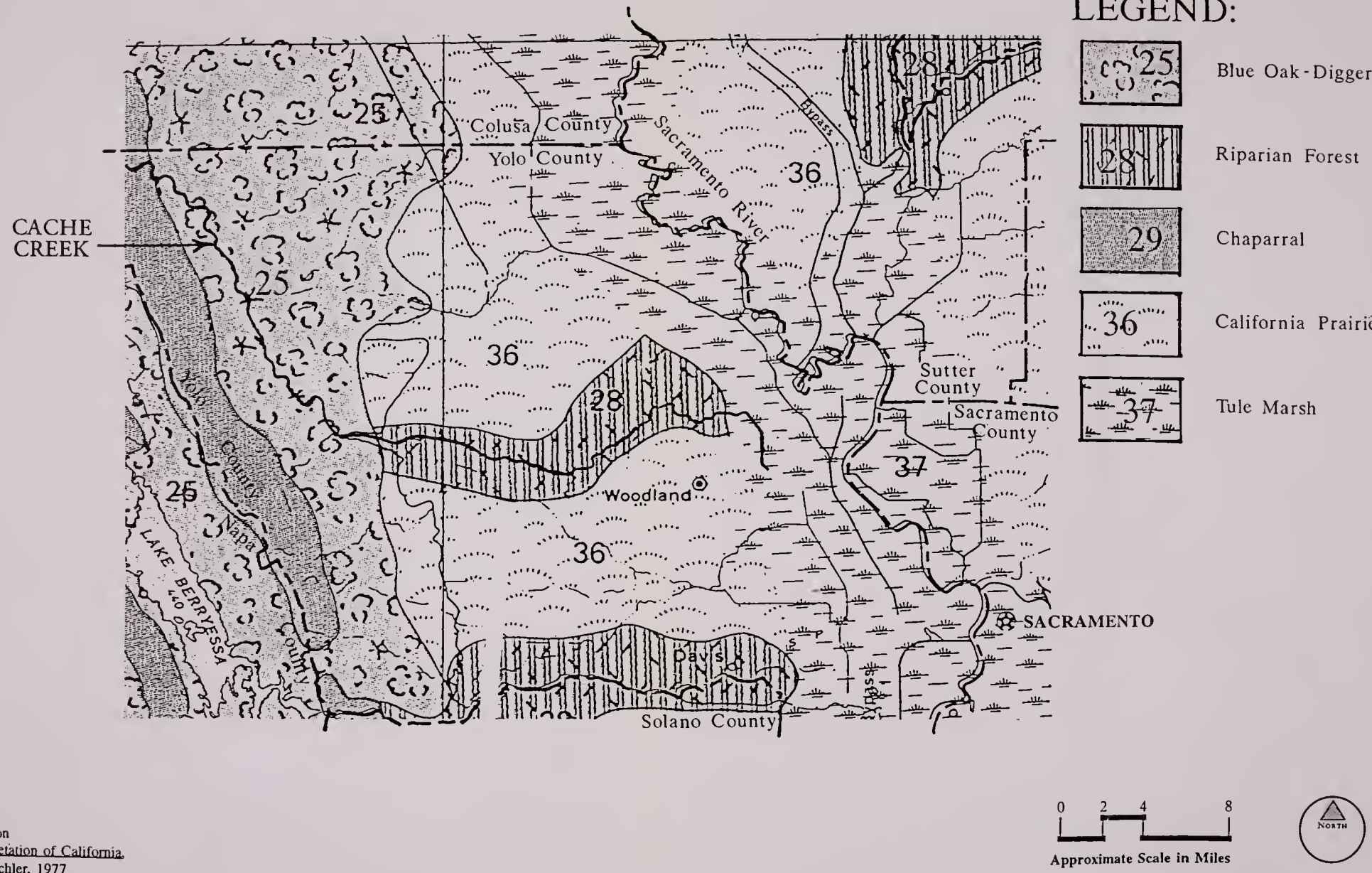
B. HISTORIC VALUES OF THE CACHE CREEK SYSTEM

1. Introduction

Much of the value of riparian systems is derived from the flow of water through a gently-sloped and vegetated channel. The combination of water, gentle slopes, and vegetation can remove pollutants from the water, increase nutrient production, flood storage and groundwater recharge, reduce storm erosion, create waterfowl and shorebird habitat, and provide passive and active recreation. The following discussion focuses on these values, as they have been described in the scientific literature, and their applicability to the historic conditions of the mining reach of Cache Creek from Capay to Yolo.

2. Methods

The Federal Highway Administration has prepared a qualitative method for evaluating riparian values based on the functions described for wetlands in the Federal Clean Water Act. The "Adamus" method, as it is termed, relies on the evaluation of a large number of factors for each wetland or wetland type.



Map based on
Natural Vegetation of California,
by A.W. Kuchler, 1977

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Pre-European Regional Habitat Map
FIGURE 2

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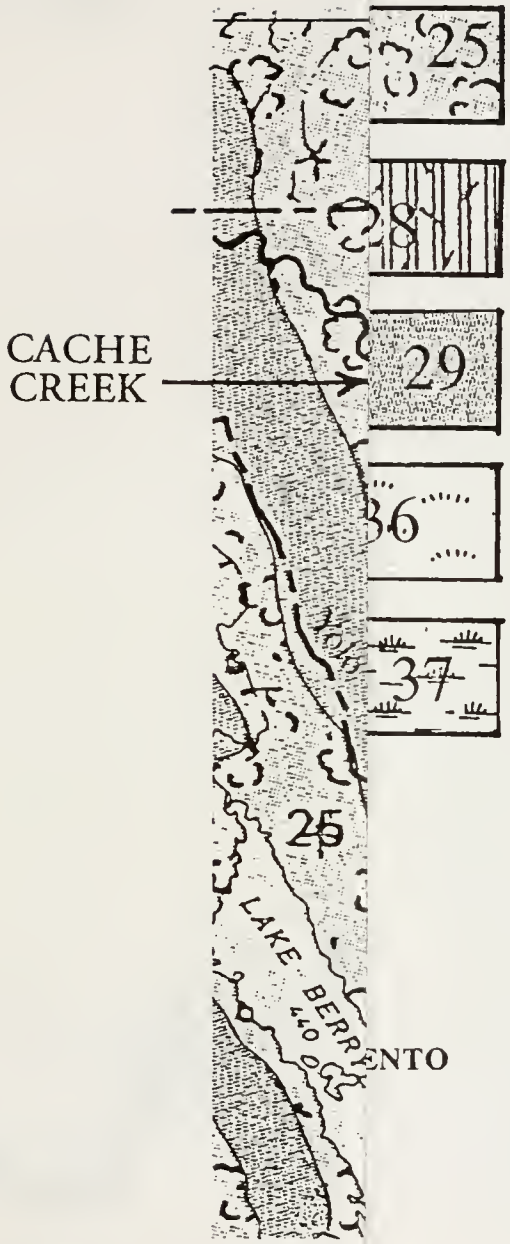

Blue Oak-Digger Pine Forest

Riparian Forest

Chaparral

California Prairie

Tule Marsh

4 8

nate Scale in Miles

NORTH

Map based on
Natural Vegetation of California,
by A.W. Kuchler, 1977

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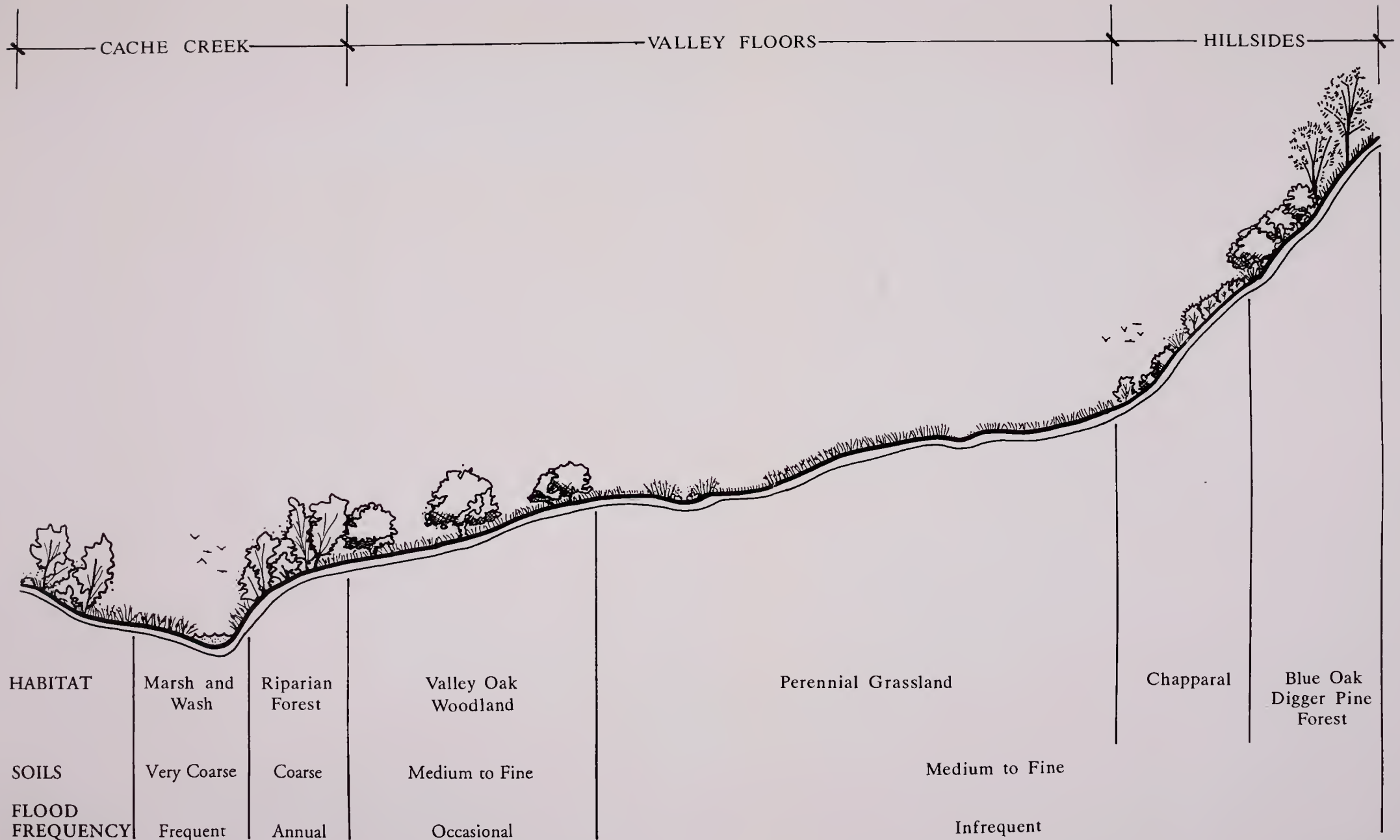
Pre-European Regional Habitat Map
FIGURE 2



Regional Habitat Cross-Section:
Pre-European Conditions

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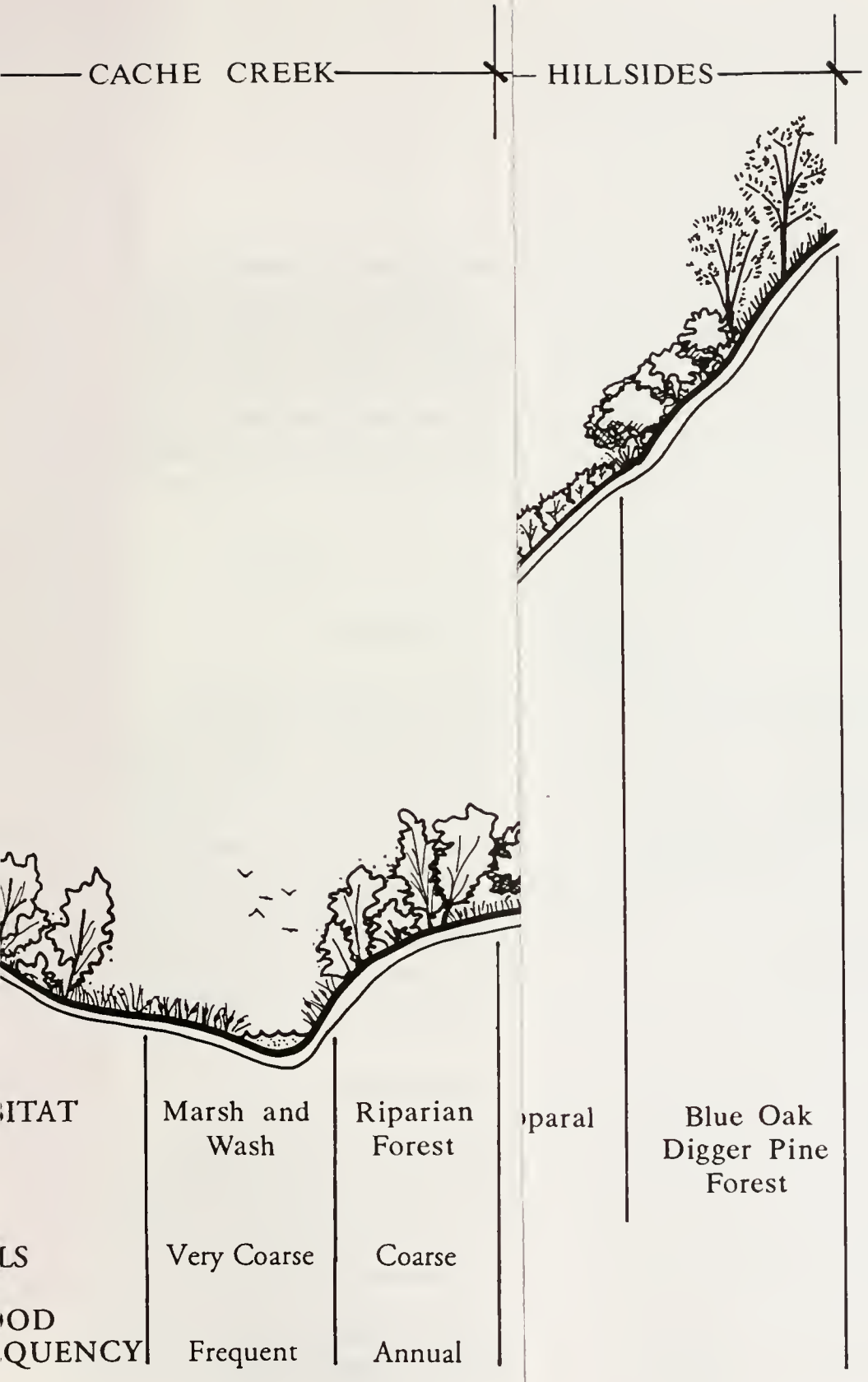
SOURCE: A.W. Kuchler (1977)
Natural Vegetation of California

FIGURE 3



Regional Habitat Cross-Section:
Pre-European Conditions

FIGURE 3

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The number of factors or "predictors" examined increases the accuracy of the results which can be used to compare the opportunity and effectiveness of different wetlands for specific values. The results are qualitative in that they are expressed as ratings of high, moderate, or low for each value or function of a particular wetland or wetland system. Because of the applicability of the Adamus technique to riparian systems and its qualitative base, an Adamus analysis was completed on the "historic" riparian system of the mining reach of Cache Creek based upon a review of historic records.

3. Results

a. Groundwater Recharge

Groundwater recharge is the movement of surface water or precipitation through a wetland and into the groundwater system. Early studies found that a substantial portion of the output of shallow vegetated wetlands becomes groundwater, thereby replenishing underground aquifers pumped for agricultural or domestic use. The Adamus method rates riparian wetlands as of high value for groundwater recharge when sufficient vegetation is available to slow flows and the soil is relatively permeable. Cache Creek has an extremely permeable substrate which promotes groundwater recharge. The historic Cache Creek included a variety of terraces, oxbows and pockets that would not only impede floodwater but that would serve to retain some portion of the yearly floods to provide for a longer recharge period.

b. Flood Reduction

Riparian systems can reduce downstream flood peaks by delaying the passage of storm flows and by storing flood waters and releasing them more gradually than adjacent uplands. Adamus found that riparian systems in some areas may reduce downstream flood peaks by as much as 60 to 70 percent. One measure of the value of riparian systems for flood protection is found in reports from flood losses in Pennsylvania. There, of the two bridges left intact (of hundreds washed out) after severe floods, both were immediately downstream of preserved riparian wetlands. Similarly, the Corps of Engineers is purchasing development rights to 2800 acres of flood-prone, riparian wetlands in the eastern

portion of Merced County to ensure flood retention continues to occur in these areas. In historic conditions, Cache Creek included vegetated channels, oxbows, and similar features which slowed flood waters. Of course, while these features provided significant downstream benefits, they also contributed to off-channel flooding in the heavily vegetated reaches.

c. Shoreline Anchoring

Riparian systems can protect waterway edges through the holding power of the vegetation's fibrous root systems. Riparian systems are typically exposed to extreme events and most riparian plants, therefore, can act as erosion control agents. The natural banks of Cache Creek were relatively gently sloped or terraced (reflecting flood events) and heavily vegetated with woody riparian species. These riparian woodlands typically had very dense cover which reflects root extent and, therefore, soil holding power.

d. Sediment Trapping

Riparian systems have the ability to remove sediment and other suspended solids from agricultural and urban runoff. Reduced sediment loads improve downstream water quality and reduce future flood hazards downstream by reducing in-stream sediment deposits which build up bed elevations. Several communities are now requiring the construction of riparian marshes adjacent to urban areas to trap sediments and improve water quality. Cache Creek has historically produced significant amounts of sediment. Sediment deposition in the channel and the ability of the channel to trap sediment before it moves downstream and increases bed elevations (and flood heights) is a product of channel contours and flood velocities. Lower velocities and a highly contoured channel with many basins, as occurred in historic condition, provides for extensive sediment deposition opportunities in upstream areas.

e. Nutrient Transformation

Riparian systems improve water quality by storing nutrients within wetland plants or sediments or by converting nitrogen nutrients to gas. Numerous

analyses have found that riparian systems can remove nitrogen, phosphorus, and other nutrient compounds from wastewater flowing through the system where the system includes an extensive system of perennial and seasonal marshes. One report estimated that waste treatment functions of a marsh can be valued at about $14,000 per acre per year if comparing the treatment capability of wetlands to conventional systems. Marshes are now being constructed throughout the U.S. to act as wastewater treatment centers. Four cases in California have been well-documented. The Arcata (Humboldt County) marshes reduce Biological Oxygen Demand (BOD) by 40 to 50 percent, suspended solids by 80 to 90 percent, and fecal and total coliform by 80 to 90 percent. The Mountain View marsh (Richmond, Contra Costa County) removes as much as 68 percent of the ammonia entering the system and almost all of the nitrate. At Fairfield (Solano County), the evaluators reported an average phosphorus reduction of 25 percent and an average nitrate and ammonia reduction of 50 to 70 percent. A San Diego project, projected to treat 100 million gallons per day (mgd) of wastewater, is reporting similar results. In historic conditions, the riparian woodlands and their associated marshes suspended flows and reduced nitrogen outputs through trapping and plant use or through conversion to gas.

f. Food Chain Support

Through their conversion of nutrients into plants and plant detritus, riparian systems convert pollutants into food for small invertebrates which, in their turn, are preyed upon by larger organisms such as sportfish or waterfowl. Numerous reports have noted the connection between the "outwelling" of nutrients from marshes and commercially important fisheries and that loss of riparian systems leads to game fish population declines. The Adamus method would rate the historic mining reach of Cache Creek as of high value for this function due to the diversity of riparian habitat types, the extent of woodlands, and the high level of retention-detention. Additionally, the Creek was then connected to the Sacramento River and the Bay/Delta estuary, where the benefits of food chain support were important.

g. Fisheries Habitat

Riparian systems provide habitat both for adult fish, for feeding and propagation, and for juveniles, primarily for predator avoidance. Several analyses have found that a substantial portion of the commercially important fish of the U.S. utilize riparian systems for some portion of their life cycle. The Cache Creek riparian wetlands would have been of high value for this function as they once supported extensive runs of salmon and steelhead and other fish.

h. Wildlife Habitat

Riparian woodlands are important habitats for migratory ducks, shorebirds, game birds such as quail and pheasant, deer, and many other species. The historic riparian system was of high value for wildlife habitat. Portions of the existing mining reach (the Moore Dam sanctuary especially) are of high value now for a variety of wildlife even under current conditions, reflecting the significant opportunities for restoration throughout the other portions of the Creek.

4. Summary

Cache Creek in the mining reach historically provided significant values for groundwater recharge, erosion control, water quality improvement and wildlife habitat. Table One below summarizes these findings.

TABLE ONE

Cache Creek Values Summary: The Historic Mining Reach

Parameter	Historic Conditions
Groundwater Recharge	High
Flood Reduction	Moderate to High
Shoreline Anchoring	High
Sediment Trapping	High
Nutrient Transformation	High
Food Chain Support	High
Fisheries Habitat	High
Wildlife Habitat	High

C. TWENTIETH CENTURY CHANGES

Katibah (1984) estimates that the Sacramento Valley held 921,600 acres of riparian forest prior to European settlement. Roberts et al. (1977) estimated that, in 1848, the Sacramento Valley contained 800,000 acres of riparian forest, based on their identification of soils which were known to contain riparian forests. Warner and Hendrix (1985) estimate that the Central Valley (the Sacramento and the San Joaquin Valleys) contained between 1.6 and 2.0 million acres of riparian forest and woodland.

Katibah et al. (1984) estimate that in 1983, 102,000 acres of riparian forest remained (about 11% of the pre-European total) in the Sacramento Valley with about 49,000 acres (48%) in a disturbed or degraded condition. Perhaps of greater concern is their conclusion that the condition of the other 52% of the remaining habitat is probably suffering severe impacts.

All native habitat types in the region, and throughout most of the western U.S., have been reduced in extent and quality by the expansion in intensive farming and water diversion activities which occurred in the early decades of the 20th century. The diversion or control of the highly variable stream flows allowed intensive farming in many areas which had not been previously considered for any activity aside from grazing. The modifications to flood and normal flows also provided for an increased level of flood protection, allowing greater settlement on historic floodplain lands.

These actions led to the elimination or significant reduction of many riparian woodlands. These areas generally had good soils for intensive farming but were constrained by yearly flooding and, due to the highly seasonal nature of the flows, often had little or no water available for irrigation during the dry summers and falls. Control of the streamflow (to some extent greatly assisted by the public works projects of the 1930s), construction of irrigation canals and ditches, and the high demand for farm products and wood led to the elimination of the extensive valley oak woodlands once associated with the historic waterways of this region.

Associated wildlife has consequently been seriously impacted as well. Large and wide-ranging mammals such as tule elk, pronghorn, grizzly bear, wolf and puma have long since been eliminated from the region. Smaller and more versatile species such as coyote, striped skunk and jack rabbit have persisted on marginal habitat. Less versatile species, such as badgers and Audubon cottontail, have been pushed into smaller and more degraded remnant habitats. Figure 4 shows a cross section of pre-farming habitats on the project site with associated wildlife, emphasizing those species which are now considered by Federal and State agencies to be rare or declining.

A. SOILS

The parent material for most of the reach is Quaternary alluvium (CDMG 1977). Its thickest local unit is sand and gravel, but the high terraces on either side of Cache Creek are largely covered by varying thicknesses of loamy material that permit it to be farmed. The reach soils can be roughly arranged on gradients from coarse texture, through moderate texture, to fine texture, which roughly reflects increasing distance from the creek and hence the mode of deposition.

The soils of the creek and flood channels have been subject to frequent flooding, with active erosion and deposition. These "soils" tend to be coarse and excessively drained, with the fine sediments washing away downstream and spreading from the creek onto surrounding lands in occasional floods. The soil series of the creek and bank, as roughly mapped by the Soil Survey (SCS, 1972), include Riverwash which is subject to frequent flooding and prolonged stream flows, and Soboba Gravelly Sandy Loam, developed from material recently deposited by the stream. These "soils" are most suited to wash and riparian woodland habitat types.

Immediately adjacent to the creek and the flood channels were flats that were subject to frequent but only brief flooding with active deposition. The soils formed in this band are a highly variable mix of relatively coarse (hence excessively drained) to medium textured loams, mapped by the Soil Survey as Loamy Alluvial Land. Groundwater tended to be relatively shallow in these areas. These soils supported the higher and drier end of the riparian woodland and lower edge of the valley oak woodland habitat. Some of the loamy alluvial land has been subject to farming and some has been mined for aggregate production over the last several decades and now forms the mined basins that are the subject of this plan.

B. HABITATS AND WILDLIFE

1. Introduction

The vegetation of Cache Creek's Coast Range Reach area and the Capay Hills is oak woodland and savannah dominated by Blue (*Quercus douglasii*) and Interior Live (*Q. wislizenii*) oaks where slopes are relatively gentle. On steeper slopes and those with ultramafic substrates woodland dominance shifts to Digger Pine (*Pinus sabiniana*) and chaparral dominated by *Adenostoma fasciculatum* and *Ceanothus cuneatus* becomes frequent. Cache Creek is lined by riparian gallery forests dominated by Valley Oaks (*Quercus lobata*), Fremont Cottonwoods (*Populus fremontii*), and several species of willows (*Salix* spp.). Capay Valley and the alluvial fans of the Hungry Hollow and Woodland reaches were originally vegetated by Valley Oak woodlands and forests. The basins north and south of Cache Creek in the Hungry Hollow Reach are now intensively farmed but probably once contained significant freshwater marsh and native grassland vegetation. Native grassland, now replaced by exotic annual grassland, also formerly vegetated the Dunnagin Hills.

Vegetation sampling along the length of the Creek completed by Zentner and Zentner point to a riparian system with a high degree of variability (Appendix A contains the survey data). The contrast, for example, between the riparian forest vegetation found along upper Cache Creek and its North Fork tributary and the halophytic vegetation dominated by *Distichlis* and *Tamarix* along its semi-saline Bear Creek tributary is dramatic. Riparian forest continues to be robust in the Capay Valley Reach but *Tamarix* is an important component there and at all points below the Bear Creek confluence. The contrast between adjacent portions of the upper part of the Hungry Hollow Reach is also particularly striking. The former is a riparian forest habitat with some open water and the latter a desert-like dry wash resulting from water diversion, historic mining, rapid precipitation infiltration through porous cobbles, and a low water table. The project area is similar in that the eastern portion exhibits considerable riparian forest development and much open water because it has shallow groundwater while the western portion is desert-like. Groundwater remains relatively shallow and riparian forest consequently robust at all downstream sample points.

Zentner and Zentner also reviewed and updated habitat maps of the Cache Creek system originally prepared by Jones & Stokes for Yolo County. Table Two shows the results.

TABLE TWO

Existing Habitats of Cache Creek

Type	Acres	Percentage
Riparian Woodland	1,517	45
Wash	1,157	32
Seasonal Wetland (Annual Grassland)	444	11
Artificial Wetland	398	10
Open Water	40	1
Marsh (Seasonal and Perennial)	37	1
TOTAL	3,595	

The system is dominated by riparian woodlands, primarily Valley Oak-dominated woodlands, in the Coast Range and Capay Valley reaches, and a desert-like wash in the mining reach. Within the mining reach, most of the woodland is found in mined basins near or adjacent to the creek, although stands still occur in the creek at the toe of the levees. Seasonal wetlands are primarily portions of the wash which receive enough inundation or soil saturation to support a limited number of wetland species. Artificial wetlands include constructed ponds and a few marshes, primarily the result of farming or mining activities. Of note is the extremely limited extent of marsh habitat.

Six distinct habitat types now occur in the mining reach including: wash, perennial marsh, seasonal marsh, riparian woodland, seasonal wetland (annual grassland), and open water. Tamarisk scrub also occurs as a subcategory of riparian woodland.

2. Wash

The wash habitat is characterized by the predominance of bare substrate and by substantial movement of coarse sediment during flood flows. These areas are typically flooded with each storm flow and are wet for substantial portions of the winter and spring. Several areas are included which have been stripped by aggregate mining and which may not be subject to any stream flows. These artificially stripped areas support vegetation which is closely comparable to that of the "natural wash", and wildlife use is much the same, hence they are lumped together for discussion. Vegetation is typically very sparse, with small patches of dense shrubbery.

The wash habitat is largely barren, with limited wildlife cover provided by scattered patches of shrubbery, young trees, and herbs. Wildlife usage is somewhat limited, but a few species prefer this habitat type over others such as the San Joaquin pocket mouse and Audubon cottontail. The seasonal wetland occurs within this habitat as a cover of non-native annual grasslands inundated often enough to support mesic species.

3. Perennial Marsh

The perennial marsh habitat is restricted to thin strips within the Creek channel. These areas have year-round standing water, which supports a set of emergent marsh plants.

The wildlife value of the perennial marsh habitat on site is limited due to its small size, but this habitat is very productive of aquatic insects and the availability of summer water is very important to many animals in the surrounding habitats.

4. Seasonal Marsh

The seasonal marsh habitat is also restricted to a few small pockets within the wash habitat that are inundated into the early summer. These areas are likely ephemeral and will shift and disappear as sediment shifts through the channel and new marshes form. This habitat is of such limited extent on site that it has little wildlife value. Many species of surrounding habitats will use this habitat as a water source during the late spring and early summer before it dries.

5. Riparian Woodland

Riparian habitat generally provides considerable cover, food, roosting and nesting for wildlife, and, therefore, is a very important wildlife habitat. The existing unmined land which supports riparian habitat is the most significant natural habitat remaining due to the abundance of native plant species and the cover provided for wildlife. However, much of the riparian woodland is primarily a result of the lowering of soil surfaces and subsequent invasion of riparian species due to mining activities. The existing natural riparian woodland habitat consists of thin strips of vegetation dominated by cottonwood and willow trees. The trees are predominantly young to moderate age, with relatively few mature trees. A majority of the live, mature trees are in poor condition, while many dead trees point to the degraded character of the habitat and six years of drought. Seedling trees are numerous, especially in the moister parts of the adjacent wash habitat.

Typically the riparian vegetation would be subject to flooding during the winter and spring, with flow continuing into the summer, and with either surface water or shallow groundwater to sustain the trees through the summer and fall. Soils of this habitat would range from coarse to predominantly fine in texture. The relative influence of controlled release of water from the dam at Clear Lake and diversions to agriculture at the Capay dam by Esparto are not clear, but may have substantially altered the water regime in this reach of the stream. The presence of numerous seedling willows and cottonwoods in the adjacent wash habitat indicated that summer hydrology is adequate to support riparian woodland, and that the lack of riparian woodland in these areas is probably due to drought or agricultural pumping cycles.

6. Tamarisk Scrub

Tamarisk scrub occupies scattered patches within and adjacent to the old riverwash creek channel. The substrate in these areas is typically coarse and excessively drained and the density of the understory plant cover ranges from very sparse to moderate. The tamarix itself provides no food, but it does provide shade and cover. Associated plants provide some food for wildlife. This habitat is used for cover by brush rabbits and Audubon cottontail. The bare ground under some of these tamarisk stands is favored by whiptail lizards. Dominance by exotic plants and abundance of barren substrate result in very low overall wildlife value for this habitat type.

7. Open-water

Open-water habitat is present in the active sedimentation basins within the existing gravel mined areas and similar habitats. This habitat is characterized by year-round standing water and by the general absence of vegetation. Most of these basins are nearly barren due to heavy recent disturbance, but older ponds (which include emergent marsh vegetation and young riparian vegetation as well as open-water) are a very productive and heavily used habitat.

The presence of fish in the pond, and a border of volunteer willow and cattail vegetation greatly enhance the wildlife values of these areas.

C. PROTECTED SPECIES

Table Three below lists the protected species possibly occurring in the mining reach which were derived from a compilation of state and federally listed sensitive animal and plant species and the Natural Diversity Data Base (CNDDB) of the California Department of Fish and Game (DFG); their protection category; and their status with regards to restoration. Status classifications including the

following: C - Likely occurrence on site; R - Not presently occurring on site but presently occurring in the region and a likely target species for restoration; O - Not presently on site or in the region but a likely target species for restoration; N - Not presently on site and not a likely target species for restoration

TABLE THREE

Wildlife		Category	Status
Valley Elderberry Longhorn Beetle	*Desmocerus californicus dimorphus*	FT	L
Vernal Pool Fairy Shrimp	*Branchinecta lynchi*	FPE	N
Vernal Pool Tadpole Shrimp	*Lepidurus packardi*	FPE	N
California Linderiella	*Linderiella occidentalis*	FPE	N
River Lamprey	*Lampetra ayresi*	CSC	N
Pink Salmon	*Oncorhynchus gorbuscha*	CSC	N
Coho Salmon	*Oncorhynchus kisutch*	CSC	N
Chinook Salmon: Winter & Spring Run	*Oncorhynchus tshawytscha*	FT/SE	N
Sacramento Perch	*Archoplites interruptus*	FC/CSC	N
Hardhead	*Mylopharadon conocephalus*	CSC	N
Sacramento Splittail	*Pogonichthys macrolepidotus*	CSC	N
California Tiger Salamander	*Ambystoma tigrinum californiense*	FC/CSC	N
California Red-legged Frog	*Rana aurora draytoni*	FC/CSC	N
Foothill Yellow-legged Frog	*Rana boylii*	CSC	N
Western Spadefoot	*Scaphiopus hammondii*	CSC	N
Northwestern Pond Turtle	*Clemmys marmorata*	CSC	R
California Horned Lizard	*Phrynosoma coronatum frontale*	CSC	R
San Joaquin Whipsnake	*Masticophis flagellum ruddocki*	CSC	N
Giant Garter Snake	*Thamnophis couchi gigas*	FC/ST	N
Double-crested Cormorant (rookery site)	*Phalacrocorax auritus*	CSC	O
Least Bittern (rookery site)	*Ixobrychus exilis*	CSC	N

White-faced Ibis (rookery site)	*Plegadis chihi*	CSC	N
Cooper's Hawk (breeding)	*Accipiter cooperi*	CSC	R
Sharp-shinned Hawk (breeding)	*Accipiter striatus*	CSC	N
Golden Eagle (breeding and wintering)	*Aquila chrysaetos*	CSC	N
Ferruginous Hawk (wintering)	*Buteo regalis*	FC/CSC	R
Swainson's Hawk (breeding)	*Buteo swainsoni*	ST	R
Northern Harrier (breeding)	*Circus cyaneus*	CSC	R
Bald Eagle (breeding and wintering)	*Haliaeetus leucocephalus*	FE/SE	R
Osprey (breeding)	*Pandion haliaetus*	CSC	R
American Peregrine Falcon	*Falco peregrinus anatum*	FE/SE	R
Merlin	*Falco columbarius*	CSC	R
Prairie Falcon (breeding)	*Falco mexicanus*	CSC	O
Greater Sandhill Crane (breeding and wintering)	*Grus canadensis tabida*	ST	N
Mountain Plover (wintering)	*Charadrius montanus*	FC/CC	
Western Snowy Plover (breeding)	*Charadrius alexandrinus nivosus*	FC/CSC	N
Long-biller Curlew (breeding)	*Numenius americanus*	FC/CSC	N
Short-eared Owl (breeding)	*Asio flammeus*	CSC	O
Long-eared owl	*Asio otus*	CSC	R
Burrowing owl (breeding)	*Athene Cunicularia*	CSC	R
Purple Martin (breeding)	*Progne subis*	CSC	N
Bank Swallow (nesting colony)	*Riparia ripari*	ST	L
Tricolored Blackbird (nesting colony)	*Agelaius tricolor*	FC/CSC	R
Yellow Warbler (breeding)	*Dendroica petechia brewstri*	CSC	N
Yellow-breasted Chat (breeding)	*Icteria virens*	CSC	O
San Joaquin Pocket Mouse	*Perognathus inornatus*	FC/CSC	N
American Badger	*Taxidea taxus*	CSC	O
Pale Big-eared Bat	*Plecotus townsendii pallescens*	CSC	N
Townsend's Western Big-eared Bat	*Plecotus townsendii*	CSC	N
Pallid Bat	*Antrazous pallida*	CSC	N

Plants		Category*	Status**
San Joaquin Saltbush	*Atriplex patula ssp. spicata*	FC	N
Palmate Birds-beak	*Codylanthus palmatus*	FE/SE	N
Adobe Lily	*Fritillaria pluriflora*	FC	O
Northern California Black Walnut	*Juglans hindsii*	FC	R
Hall's Madia	*Madia hallii*	FC	N

NOTES: *Categories are as follows:

FE	Federally listed as endangered
FT	Federally listed as threatened
FPE	Proposed for federal listing as endangered
FTP	Proposed for federal listing as threatened
FC	Federal candidate for listing
SE	State listed as endangered
ST	State listed as threatened
CSC	State Fish and Game species of special concern

A number of species are presently known from the region and might occur in the reach with the restoration of appropriate habitat. These species include the bank swallow, Swainson's Hawk, burrowing owl, and tricolored blackbird. Several other species are not now known from the region but could be re-introduced under appropriate conditions such as the prairie falcon and adobe lily.

D. SUMMARY

The existing conditions represent a significant change from the pre-European conditions. The creek has been deepened and the banks built up and steepened to reduce off-creek flooding. The riparian woodlands, marsh, and open water habitats once common in the creek have been significantly altered or eliminated.

These changes are reflected in the large number of rare species known from or now extinct in the region. Restoration of a more diverse habitat, especially one which includes open water and marshes, can promote significant habitat improvements and compatible with existing soil and hydrology. The existing but small marsh/pond complexes and the marshes in the creek have much higher bird use and species diversity than barren slopes or wash habitats. The small areas of habitat and their relatively great wildlife use point to the significant opportunities for restoration activities in the reach.

E. EXISTING VALUES OF CACHE CREEK IN THE MINING REACH

The following discussion focuses on riparian values as they have been described above for the Adamus technique. These results are relatively general but they provide a good comparison of the historic condition of the system with today's reality.

1. Groundwater Recharge

Cache Creek has an extremely permeable substrate which promotes groundwater recharge. However, bank and stream bottom vegetation is almost non-existent and the shape of the channel (a trapezoid in most cases) promotes the prompt downstream movement of water rather than the retention of floodwater in pockets and oxbows as would occur in an idealized system that then results in groundwater recharge.

2. Flood Reduction

The Adamus method would rate the existing mining reach of the Creek as of moderate value for downstream flood protection due to the near-absence of significant stands of woodland vegetation and the relatively flat and uncontoured bottom. In essence, Cache Creek today is acting like an unvegetated, trapezoidal flood channel which protects the immediately adjacent lands but tends to increase velocities and downstream flood peaks, thereby promoting downstream flooding.

3. Shoreline Anchoring

The Adamus method rates the existing Cache Creek riparian system in the mining reach as of low value for shoreline protection due to the near-absence of woody riparian vegetation and the steepness of the channel banks. This value is reflected in the large amounts of sediment which slough off from the banks during almost any flood event and the erosion which is occurring on the banks at many locations.

4. Sediment Trapping

Cache Creek has historically produced significant amounts of sediment. However, with the construction of Clear Lake and Indian Valley Reservoir, the amount of sediment in the channel may be as or more reflective of existing cultural practices than of historic soil and geomorphologic conditions. Based upon our surveys of the Creek, the combination of watershed grazing and over-steepened channel banks provides for significant sediment movement into the channel from adjacent lands. A flat-bottomed channel, such as occurs in the project area, and high velocities, which also occur commonly in the mining reach, provides for poor deposition opportunities, except for the heaviest materials. Consequently, coarser aggregate is being actively deposited in the mining reach but deposition of finer material (primarily silts) in the downstream settling basin is becoming significant.

5. Nutrient Transformation

The Creek in the mining reach is of low value for this function. The extent of marshes is extremely limited and retention time within the channel for flood flows is low (see discussions above on sediment deposition and flood protection).

6. Food Chain Support

The Adamus method would rate the existing mining reach of Cache Creek as of low value for this function due to the low diversity of riparian habitat types, the limited extent of woodlands, and the low retention-detention times.

7. Fisheries Habitat

The Adamus method would rate the existing system as of low value due to the absence of perennial water, the channel conditions, and the lack of any connection to the Sacramento River.

8. Wildlife Habitat

The existing system is of moderate to low value for wildlife due primarily to the low diversity of the habitats.

9. Summary

Table Four compares the existing condition of the Creek in the reach with the probable historic condition as described above.

TABLE FOUR

Cache Creek Values Summary: Mining Reach

VALUES

Parameter	Existing Conditions	Historic Conditions
Groundwater Recharge	Low to Moderate	High
Flood Reduction	Low to Moderate	Moderate to High
Shoreline Anchoring	Low	High
Sediment Trapping	Low to Moderate	High
Nutrient Transformation	Low	High
Food Chain Support	Low	High
Fisheries Habitat	Low	High
Wildlife Habitat	Moderate	High

The Cache Creek riparian system in the mining reach now has low to moderate values resulting from the deep, trapezoidal shape, the absence of topographic variation and natural channel forms, and the low habitat diversity. Existing conditions, i.e., the deep trapezoidal contours, do provide for the reduction of flood hazards and for the deposition of the heaviest sediment within the mining reach. However, these same conditions increase flooding downstream, promote the movement of fine sediment into the settling basin (where it reduces basin capacity and further exacerbates flood heights), encourage bank erosion and significantly limit the habitat value. The creek system does have significant restoration potential, though, as reflected in the historic values.

Chapter 4
Habitat Restoration

A. GOALS

The goals for the restoration plan include the following:

1. Restore the creek channel to a configuration which will increase the natural values of the Creek as described above.

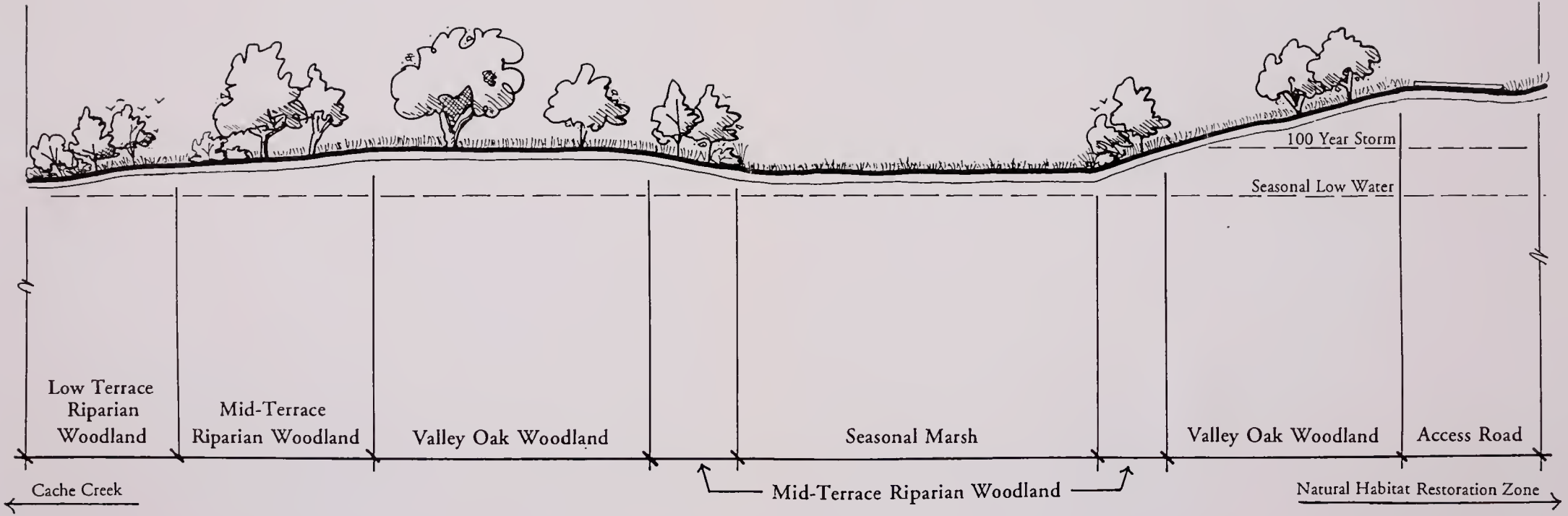
2. Restore high quality natural habitat dominated by appropriate native plants to those areas not reclaimed for agricultural uses.

3. Provide an appropriate monitoring and maintenance program, including financing, that will ensure that restoration is successful.

B. PLAN DESCRIPTION

1. Introduction

The proposed plan will provide for greatly enhanced diversity of the creek (see Figures 4 through 6 for cross-sections). Mature and viable cottonwoods and other low-terrace riparian woodland species now found at the toe of the existing levee will be preserved. Above this, the existing mined basins will be either excavated or sloped back to create a series of terraces and relatively gentle slopes and then planted with native species. This will increase flood capacity and desynchronization (slowing flood flows to reduce peak discharges downstream), increase groundwater recharge (by slowing flows and allowing increased percolation), and increase natural habitat and wildlife values (by replacing a relatively steep levee slope with few native plants with a gentler slope dominated by natives) by replicating features of the natural topography.



SCALE: 1"=30'-0"

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Mined Basin After Restoration
FIGURE 4

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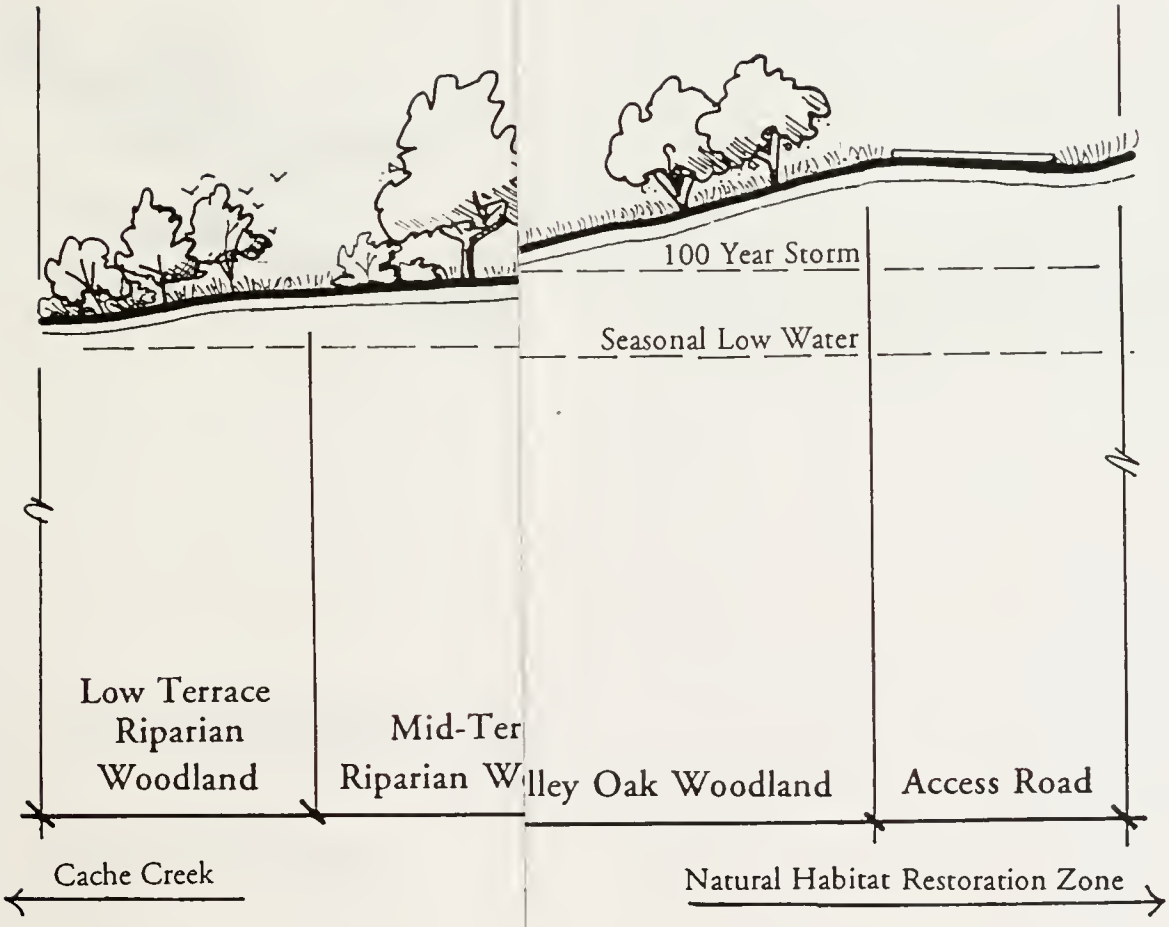

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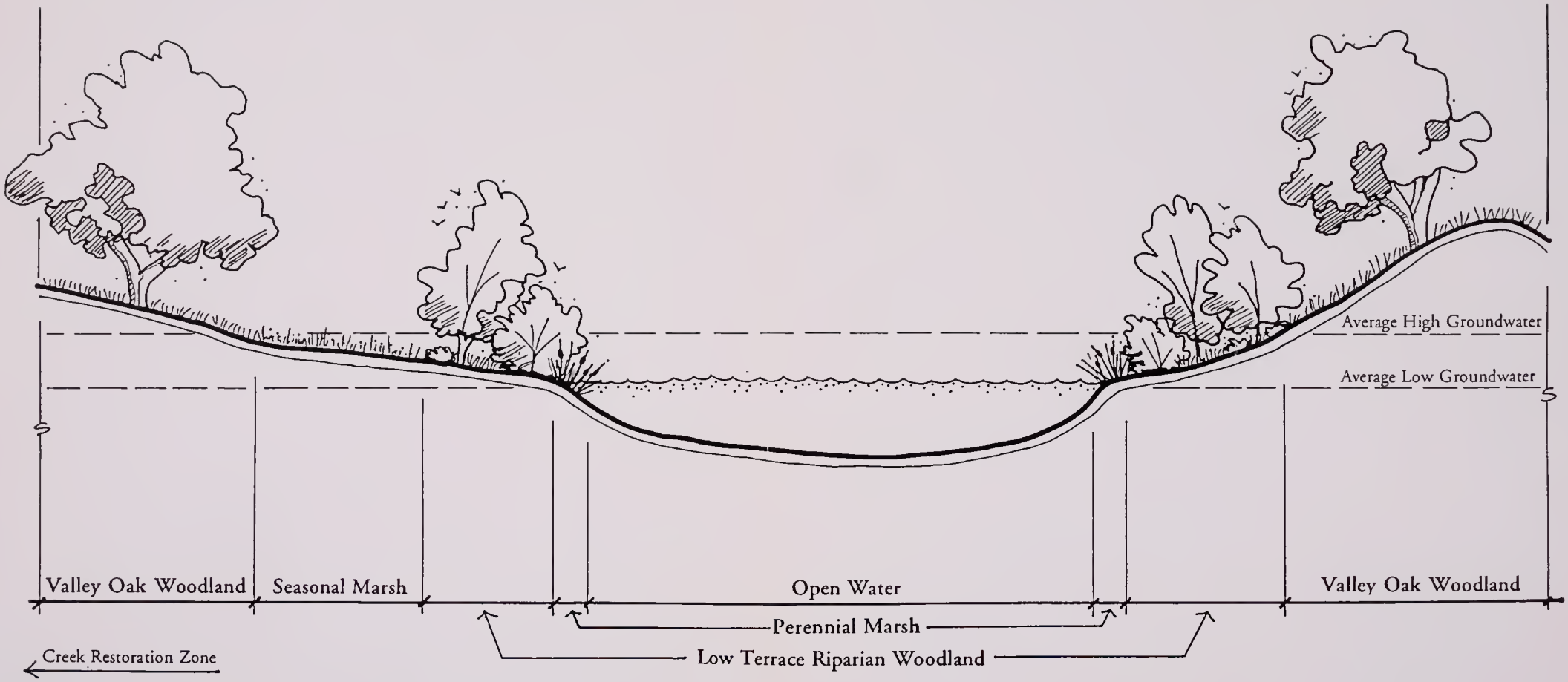
Mined Basin After Restoration

FIGURE 4



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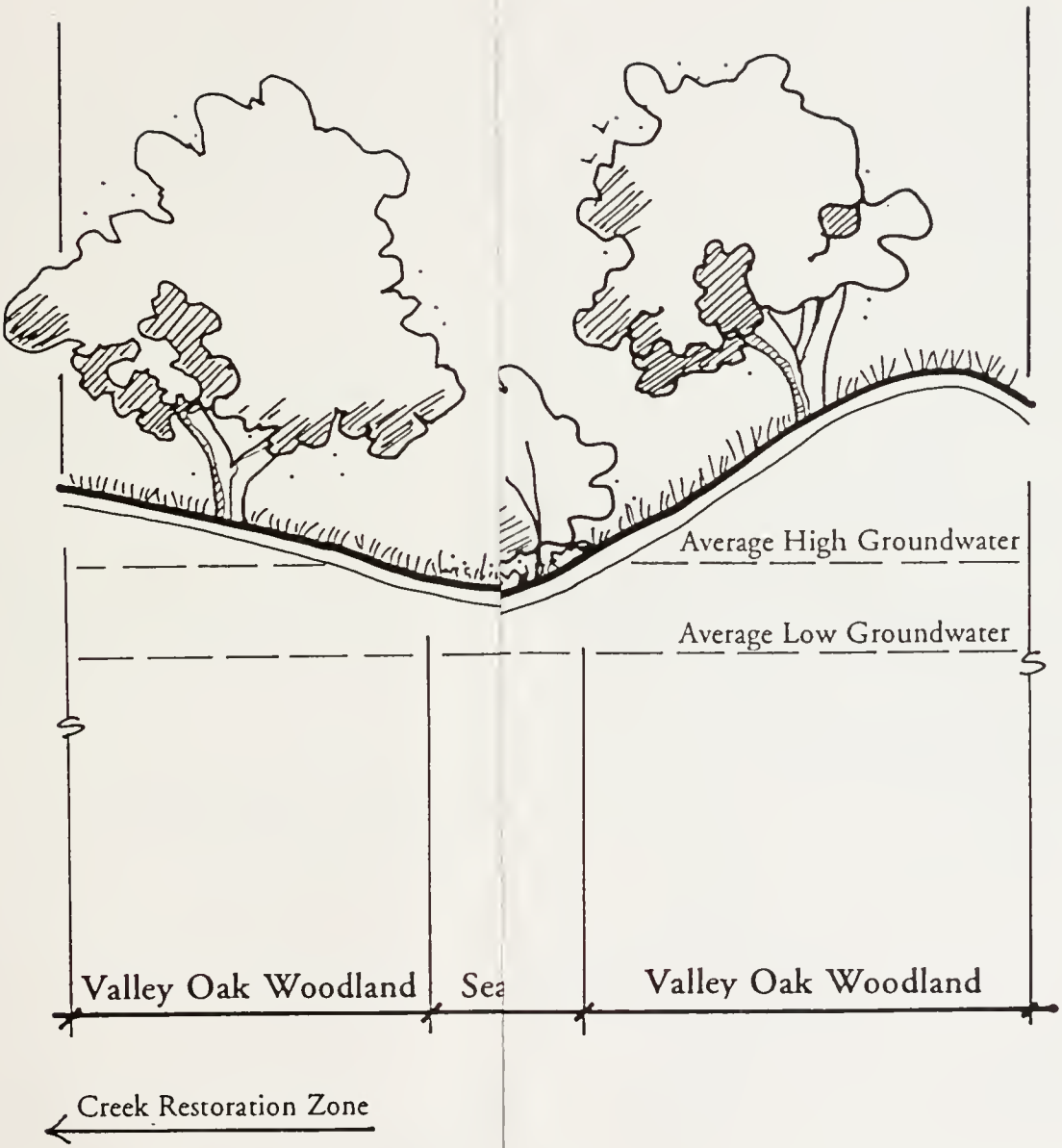
Mined Basin After Restoration
Hydrology Detail

FIGURE 5



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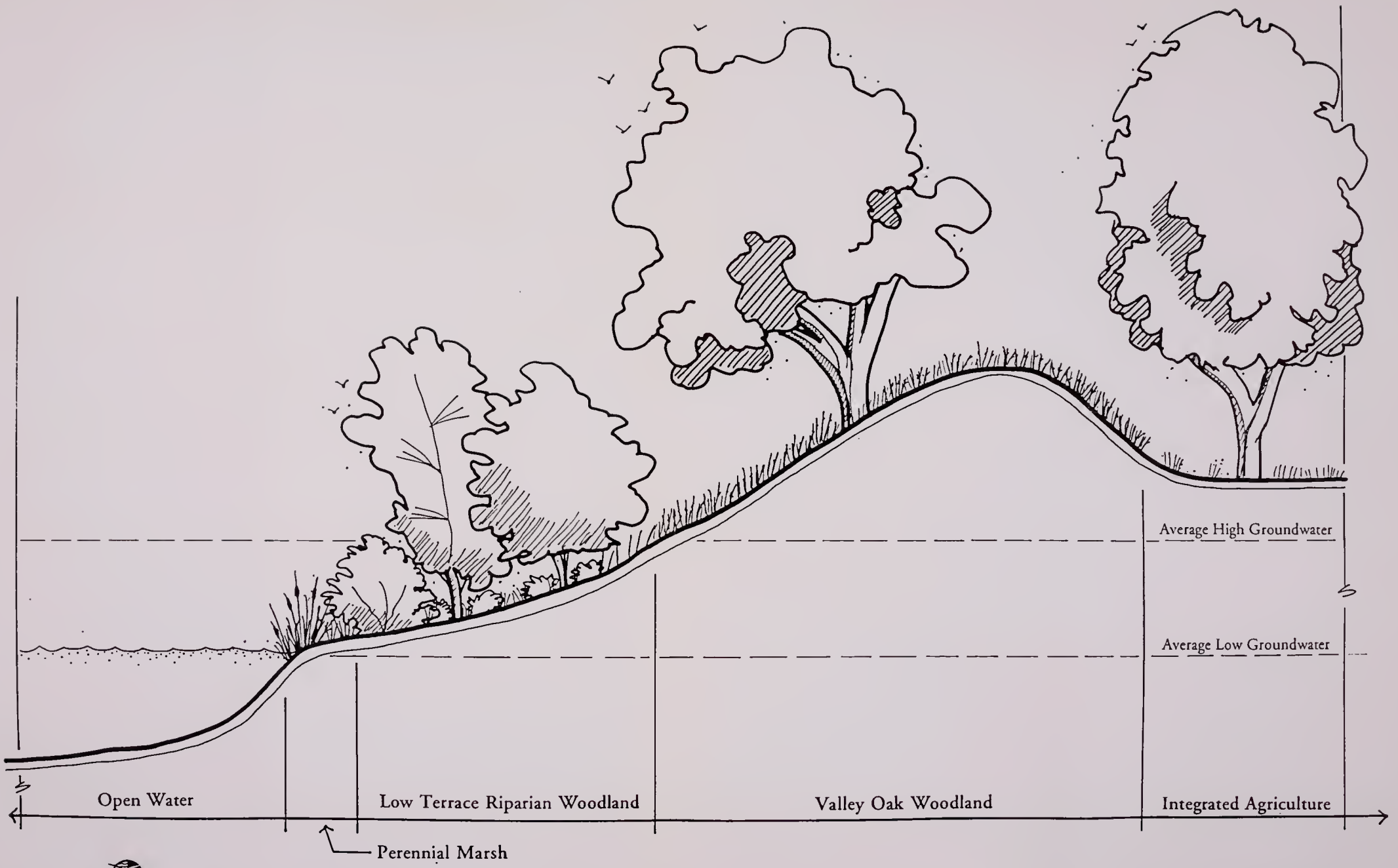
Mined Basin After Restoration
Hydrology Detail

FIGURE 5



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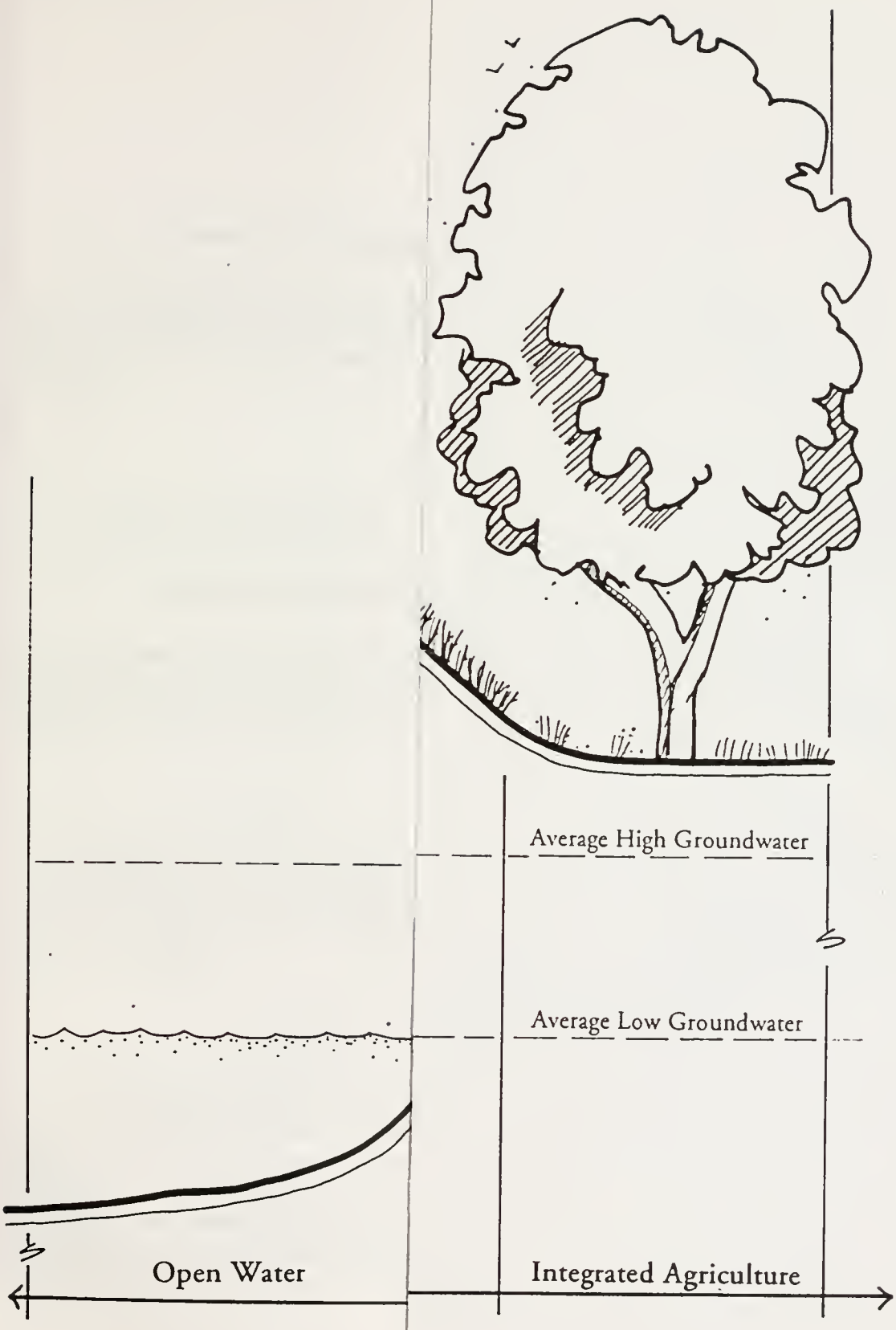
Mined Basin After Restoration
Slope Detail

FIGURE 6



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Mined Basin After Restoration
Slope Detail

FIGURE 6

2. Ownership and Financing

Private landowners have title to or options on all of the land within the proposed reclamation program area. The Yolo County Flood Control and Water Conservation District shall be responsible for all construction and monitoring of the project.

C. HABITAT DESCRIPTIONS

1. Open Water and Marsh Habitats

The open water and marsh habitats are discussed together because they generally occur as a unit, with marsh typically occurring as a fringe in the shallows at the edge of the open water habitat.

a. Goals

The primary goals of this effort are the creation of a diverse open water and marsh system, and the assurance that this system will be self-maintaining to the maximum extent practicable without creating problems such as excessive mosquito production.

b. Open Water Habitat Construction

Habitat diversity will be a product of providing a mix of open water and marsh, with adjacent riparian woodland and oak woodland. Presently, the site and the region have a very limited amount of marsh and open water. Additionally, the naturally-occurring surrounding habitat, which can be very important to many species for roosting, nesting, and cover, is currently preempted by farming or is otherwise considerably degraded. Restoration of each of these systems will satisfy the habitat diversity goals.

One of the more difficult tasks in wetland creation is ensuring that the wetland is self-maintaining. The presence of large numbers of mosquitos is a good indication that a project is not tending toward self-maintenance. The Sacramento-Yolo Mosquito Abatement District has developed guidelines for use in wetland restoration projects. These were used to develop a series of guidelines for this project discussed below.

1. The banks of areas that retain water after June 1 (the beginning of the optimal mosquito breeding period) will be steep enough to prevent isolated pooling as the water level recedes and to allow wave action and access by predators. Shoreline configuration will not isolate small channels or shallow ponding areas from the main body of water but will instead provide for continuous access by predators, particularly mosquito fish.

2. Water depth will be maintained at a minimum of two feet during warm mosquito breeding months (June - October) in perennial marshes. Hydroperiod analyses have shown that perennial marsh will flourish with two to three feet of water depth during the warmer months.

3. Dense stands of aquatic vegetation will be limited in shallow areas to lower harborage and enhance wave action. Perennial marsh species, like cattails and bulrushes, in moderate stands generally do not promote mosquito productivity and will function as substrate for predators of mosquitos.

4. Wetlands will be stocked with the mosquito fish (*Gambusia affinis*) or other insectivorous fish.

5. Road access will be provided to all wet areas. Access will be allowed for continual larval and adult mosquito surveillance and the continual monitoring of water quality and vegetation density.

c. Marsh Construction

Project goals for marsh construction focus on the provision of a diverse habitat while avoiding some of the potential problems of constructed marshes such as increased mosquito production. Marsh vegetation can be established on moderate to fine textured sediments, as long as surface water is present for sufficient duration during the growing season. Perennial marsh soils will be provided by fines and clays encountered during surveying.

Perennial marsh requires at least six months and preferably at least nine months of inundation and can withstand depths of up to three feet of water during this period. Seasonal marsh requires two to six months of shallow inundation or soil saturation.

Experience has demonstrated that planting the mature marsh species in their proposed establishment zone is cost-effective and provides for rapid establishment of a diverse marsh flora. Planting of perennial marsh species is implemented by salvaging plugs of native marsh plants like *Scirpus acutus*, *S. californicus*, and *S. olneyi* from perennial marshes in the vicinity. The plugs are then planted on six-foot centers in the appropriate areas. Transplanting of marsh root masses (the preferred planting strategy) can be extremely successful where the root masses are kept inundated from the time of transplanting and transplanting occurs almost immediately (within hours) after salvaging.

Efforts will additionally be made to plant rare marsh species that occur in this region such as *Sagittaria sanfordii* and possibly *Hibiscus californicus*. Their seed will be collected locally and propagated prior to planting at the project site.

Species to be planted in the marsh habitat are shown in Table Five.

TABLE FIVE

Marsh Planting List

Species	Common Name	Approximate # Per Acre
Scirpus acutus	Common tule	30
Eleocharis palustris	Creeping spikerush	20
Typha domingensis	Cattails	15
Scirpus americanus	Three-square	10
Agropyron trachycaulon	Slender wheatgrass	5
Phalaris arundinacea	Reed Canary Grass	5
Carex rostrata	Beaked sedge	5
Equisetum hyemale	Scouring Rush	5
Anemopsis californica	Yerba Mansa	5
Hibiscus californica	California Hibiscus	5
Cephalanthus occidentalis	Buttonbush	5

d. Probable Wildlife Use of Created Marsh and Open Water Habitats

The marsh and open water areas are important wildlife habitats, and are also very important as water-sources. The small size of the existing areas and the barrenness of adjacent areas, however, severely restricts wildlife usage. The creation of additional marsh and open water areas and the restoration of adjacent upland habitats will substantially expand the wildlife value of these areas.

Some species which will be promoted by expansion of these habitats types by the restoration of adjacent upland habitats include: raccoon, American bittern, great blue heron, great egret, snowy egret, green-backed heron, black-crowned night heron, American coot, swallow species, valley garter snake, aquatic garter snake, Pacific tree-frog, bullfrog, California toad, pied-billed grebe, double-crested cormorant, ruddy duck, belted kingfisher, and many others. Especially important is the provision of habitat for the tricolored blackbird, a protected species.

2. Riparian and Oak Woodland Habitats

a. Planting

Woodlands will consist of riparian woodland on the low ground surrounding the marsh and open-water habitats of the site, and valley oak woodland on the high ground surrounding the areas of the riparian habitat. Additionally, preserved riparian and oak woodland will be enhanced to comparable densities.

Based on soils (SCS, 1972) most of the project area was historically oak woodland with stringers of riparian woodland along the major stream channels. Associated native grasslands were probably dominated by creeping wild rye (*Elymus triticoides*) with some purple needle grass (*Stipa pulchra*) on higher and drier sites. The riparian woodland occurred on the relatively coarse soils with high year-round groundwater along the creek channels, while the oaks occurred (and still occur) on the drier and relatively coarse loams of the relatively broad natural levees that flanked the major creek channels of the area, and grasses dominated the finer grained soils farther from the creeks. To reestablish riparian woodland will require generally coarse slopes, while oak woodland will require moderate- to fine-textured loams. Cobbly loam, gravelly loam or other loamy textures are acceptable as a subsoil for both woodland types but clays are not suitable. If any significant clay areas are encountered, the plantings will be modified toward open woodland or grassland as appropriate.

The riparian woodland will be established around all areas of open water and marsh habitat. Species to be planted in the riparian woodland area (roughly arranged from drier to wetter conditions) are found in Table Six.

TABLE SIX

Riparian Woodland Planting List

Species	Common Name	Approximate # or lbs/acre
Quercus lobata	Valley oak	33
Rosa californica	Wild rose	36
Elymus triticoides	Creeping wildrye	16 lbs
Sambucus mexicana	Blue elderberry	12
Rubus ursinus	Native blackberry	19
Baccharis viminea	Mule fat	6
Vitis californica	Wild grape	16
Acer negundo	Box elder	18
Cornus stolonifera	Dogwood	16
Populus fremontii	Fremont cottonwood	26
Salix goodingii	Black willow	23
Salix laevigata	Red willow	23
Salix lasiandra	Arroyo willow	23
Artemesia douglasiana	Mugwort	10

Average densities will be over 300 trees and shrubs per acre. The trees and shrubs will be planted in clusters. The woodland will appear relatively dense with occasional grassland openings.

The higher ground surrounding the riparian woodlands will be planted in valley oak woodland. Species to be planted in the oak woodland areas are shown in Table Seven.

TABLE SEVEN

Oak Woodland Planting List

Species	Common Name	Approximate # or lbs/acre
Pinus sabiniana	Gray pine	3
Quercus wizlensii	Interior live oak	6
Quercus lobata	Valley oak	20
Aesculus californica	California buckeye	5
Sambucus mexicana	Blue elderberry	10
Rubus ursinus	Native blackberry	8
Baccharis pilularis	Coyote bush	10
Rosa californica	Wild rose	15
Stipa pulchra	Purple needlegrass	5 lbs
Elymus triticoides	Creeping wildrye	16 lbs
Bromus carinatus	California brome	10
Hordeum californicum	California barley	5
Poa scabrella	Pine bluegrass	5
Brodiaea elegans	Elegant brodiaea	0.1 lbs
Chlorogalum pomeridianum	Soap plant	5
Clarkia unguiculata	Mountain garland	0.1 lbs
Collinsia heterophylla	Chinese houses	0.1 lbs
Gilia tricolor	Bird's eyes	0.1 lbs
Lupinus latifolius	Sundial lupine	0.1 lbs
Montia perfoliata	Miner's lettuce	0.1 lbs
Nemophila menziesii	Baby blue eyes	0.1 lbs

Average densities will be 100 trees and shrubs per acre. However, these trees and shrubs will be planted in clusters of six to seven trees or shrubs. The clusters will typically consist of a single species, although mixed groupings, e.g., Valley Oak-Elderberry would also occur. Gray pine will only be planted as individuals at the higher points on the site. Clusters of trees and shrubs will be planted 25 to 50 feet apart with native grasslands in between the clusters.

b. General Planting Requirements

After any excavation these areas will be graded to a constant slope and the slopes will be disced, cross-disced and ring-rolled to prepare a seedbed. Several areas will be left as steep, barren slopes, however, to provide habitat for the bank swallow. No additional soils will be placed in this area so as to avoid the introduction of weed seeds. Soil tests after seedbed preparation may point out the need for soil amendments. The native grasses to be planted on these slopes are adapted to low nutrient regime conditions and should not require significant amendments. All trees and shrubs planted in this zone should be planted with a slow-release fertilizer.

Many of the low terrace riparian trees in the restoration site will be planted with pole cuttings taken from nearby trees. Most of other trees and shrubs will have been grown in D-pots or similar containers.

c. Probable Wildlife Use of the Woodland Habitats

The riparian and oak woodland habitats are important wildlife habitat types. The small size of the existing areas and the degraded nature significantly limits wildlife usage. The creation of additional riparian and oak woodland areas and the reintroduction of numerous native plant species to both preserved on created areas will substantially improve the wildlife value of these areas.

The list of species which will be promoted by expansion of the riparian and oak woodland habitats is very long, and includes: dusky-footed woodrat, mule deer, great horned owl, screech owl, Lewis woodpecker, ruby-crowned kinglet, western bluebird, blue-gray gnatcatcher, solitary vireo, California king snake, California night snake, white-tailed kite, Cooper hawk, Swainson's thrush,

hermit thrush, blue-gray gnatcatcher, cedar waxwing, Hutton's vireo, orange-crowned warbler, common yellow-throat, black-headed grosbeak, rufous-sided towhee, dark-eyed junco, Pacific rubber boa, coachwhip, sharp-tailed snake, ring-necked snake, California toad, Pacific tree-frog, and many others. Especially important, and targets for restoration, include the bank swallow, Swainson hawk, and burrowing owl, all protected species.

Chapter 5
Monitoring

A. INTRODUCTION

Monitoring is divided into two phases. The first phase involves monitoring of the construction project to ensure its compliance with the restoration program. The second monitoring phase will be a study of changes to the habitats after construction to show whether or not the existing and created vegetation is developing as intended.

B. CONSTRUCTION MONITORING

Construction of all or any portion of this project will be completed by the District. All construction that affects either preserved or created habitats shall be monitored by a qualified ecologist with proven experience in the areas of habitat development and restoration, hereafter termed the "Ecological Monitor" (EM).

During the construction phase, it is the responsibility of the EM to ensure that the project is built in accordance with the mitigation program. The EM shall inspect all aspects of habitat construction that relate to implementation of the program and shall keep a daily construction log of all relevant construction activities.

C. POST-CONSTRUCTION MONITORING

1. General Requirements

Post-construction monitoring of created natural habitats shall occur for five years after reclamation of each unit of mined habitat. Monitoring and construction may be phased such that segments of the project area are monitored at different times.

The results of the monitoring program, including photographs taken along permanent transect lines, shall be submitted in an annual report to the relevant county, state and federal agencies by August 15 of each year.

2. Monitoring Parameters

a. Woodlands

Introduction

Elements of the monitoring program discussed in this section include: woodland (tree and shrub) mortality, vigor, height, and natural regeneration; herb strata (marsh) cover and species richness; and water surface elevations.

Woodland Monitoring

Mortality rates, vigor, and height of all planted trees and shrubs will be evaluated by field surveys during both the early spring and late summer (the period of early emergence of new growth and that of greatest stress on the planted vegetation, respectively). Each planted tree or shrub will be assigned to one of three height classes: Class 1 plants will be trees 24 inches or less in height, shrubs 12 inches or less in height, and vines 12 inches or less in diameter; Class 2 plants will be trees from 24 to 60 inches in height, shrubs from 12 to 36 inches in height, and vines from 12 to 36 inches in diameter; Class 3 plants will be trees greater than 60 inches in height, shrubs greater than 36 inches in height, and vines greater than 36 inches in diameter. At the same time, the Monitor will assign each plant to a category of healthy, unhealthy, or dead. Photographs of each type of plant for a representative sample will be included in the monitoring reports. Woodland monitoring shall also include an inventory of all native trees and shrubs that germinate on-site without artificial propagation and reach a height of 36 inches or more. The height, number, and species of these plants shall be reported in the monitoring reports.

b. Marsh and Open Water Monitoring

Permanent plots marked by rebar or other, permanent markers in marshes will be used to assess plant cover, species richness, and the relative cover of wetland species. Sampling will use releves in accordance with the procedure described by Mueller-Dumbois and Ellenberg or similar procedure. Plot locations shall be divided equally among those placed on the edges of the proposed habitat and those placed within the interior of the proposed habitat. Within those two areas, locations shall be randomly selected. Sampling will occur once annually during the late spring.

These plots shall also be monitored each month of the wet season for water surface elevation and inundation period for the first two years of the monitoring period. Water surface elevation monitoring shall consist of a permanent marker (the rebar marker noted above may be used) that can be used to define water depth.

3. Schedule

Table Eight summarizes the monitored elements, the frequency of monitoring by element, the time of year for monitoring, and the years during the monitoring period in which the element is monitored.

TABLE EIGHT

Monitoring Program Summary

Element	Frequency	Season	Years
Woodland Vigor, Height & Mortality	Biannually	Spring & Fall	Each Year
Marsh Hydrology	Bimonthly	Winter & Spring	First 2 Years
Marsh Cover & Species Richness	Annually	Spring	Each Year

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Personal communications: information on the Cache Creek avifauna was graciously provided by Jim Estep, Joe Farnham, Joan Humphrey, Janet Levers, Bruce Maxwell and Richard Sykes.

APPENDIX A

CREEK VEGETATION SURVEY RESULTS

Riparian vegetation along Cache Creek (CC) and its Bear Creek and North Fork tributaries was numerically sampled at 14 points:

1. CC at Hwy 29 near its Clear Lake Outlet in Lake County.
2. North Fork CC at Hwy 20 in Lake County.
3. Bear Creek at Hwy 20 in Colusa County.
4. CC Canyon at Hwy 16 bridge in Yolo County.
5. CC at Road 41 in Capay Valley, Yolo County.
6. CC at Road 57 in Capay Valley, Yolo County.
7. CC at Road 82B near Capay Dam, Yolo County.
8. CC at Road 85, Hungry Hollow, Yolo County.
9. CC at Road 87, Hungry Hollow, Yolo County.
10. CC at Hwy 505, Hungry Hollow, Yolo County.
11. CC at Road 94B, Woodland Reach, Yolo County.
12. CC at Interstate 5, Woodland Reach, Yolo County.
13. CC at Hwy 113, Woodland Reach, Yolo County.
14. CC at Road 102, Woodland Reach, Yolo County.

Sampling utilized the Braun-Blanquet Cover Abundance Scale in which the following numerical values are given to the indicated percent coverages:

Numerical value	Percent coverage
5	>75%
4	50-75%
3	25-50%
2	5-25%
1	1-5%
+	<1%

Results are given in the table below. Numbers across the top correspond to the sample points given above. Species by family and non-vegetation types are listed along the left side of the table.

	SAMPLE POINTS													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Non-vegetation														
Open water	5	2	3	4	4	3	3	2			3			
Gravel and cobbles		2	1			2	4	4	5	5	3	4	2	4
Anacardiaceae														
Toxicodendron diversilobum												2		
Aristolochiaceae														
Aristolochia californica					+									
Asteraceae														
Ambrosia psilostachya				1	1									
Artemisia douglasiana					1					+			2	
Aster exilis						1								
Baccharis viminea				+	+			1	1	1	2			+
Centaurea solstitialis										1				
Conyza canadensis										1				

	SAMPLE POINTS													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Gnaphalium chilense							1							
Lactuca serriola														1
Solidago occidentalis	+	1												
Xanthium strumarium	+	+					1	1		+				3
Betulaceae														
Alnus rhombifolia	1	1												
Boraginaceae														
Heliotropium curassavicum									+	+				
H. europaeum										+				
Brassicaceae														
Brassica geniculatum								1	+	+				1
Lepidium latifolium			1						+	+				
Chenopodiaceae														
Atriplex patula hastata										+				
Cyperaceae														
Scirpus acutus	1						+							
S. olneyi			1											
Fabaceae														
Melilotus alba				2	1	+		2		+	2		2	2
Fagaceae														
Quercus lobata	1	+			2	1	+					1	2	
Juglandaceae														
Juglans hindsii					1	+	+	+		+	+		1	+
Loasaceae														
Mentzelia laevicaulisy								+		+				
Poaceae														
Agropyron elongatum			1											
Arundo donax						+	1	+		1	1	1		
Cortaderia atacamensis				1	1	1	1	+			+			
Crypsis schoenoides							1							
Cynodon dactylon				1						+				1
Distichlis spicata			3											
Leptochloa fascicularis							2			+	1			
Paspalum distichum				2	1	1								
Phragmites australis	1													
Poa annua							1							
Rosaceae														
Rosa californica	1	1			1							2	1	
Rubus procerus	1	+										2		
Rubus ursinus	+													
Rubiaceae														
Cephalanthus occidentalis				+										
Salicaceae														
Populus fremontii	1	1		+	2	1	+	2	+	+	1	3	4	2
Salix gooddingii	1							+		1	1	1	1	2
S. hindsiana	1	1		2	2	1		1	+	1	2			2
S. laevigata	1	2		2	1	1	+	+	+	+	1		2	
S. lasiolepis	+													+
Sambucaceae														
Sambucus mexicana						+						+	1	+
Solanaceae														
Nicotiana glauca								+						1
Tamaricaceae														
Tamarix parviflora			2	2	2	3	2	3	1	2	2	2	3	3
Typhaceae														
Typha domingensis				2	2	1	+	2			+			
T. latifolia		2												
Vitaceae														
Vitis californica				+	1						+	+		

The pools which met the standards are summarized below:

Standard	Pool(s)	% of All Pools
Relative Wetland Plant Cover	2,4,8,15,17, 20	30%
Plant Cover	4,10,13-15, 17-20	40%
Species Richness	all	100%

The marsh transect had 74% relative wetland plant cover, 99% plant cover, and 15 species. The seasonal marsh already meets all performance standards, which are 60% wetland plant cover, 70% plant cover, and 8 species.

C. WOODLANDS

1. Methods

In June, 1993 all woodland basins were inspected for the height and health of planted woodland species. Each basin was assigned a height class and a health class. The height classes are: 1 = <24"; 2 = 24-60"; 3 = >60". The health classes are: H = healthy; U = unhealthy; D = dead.

2. Results

The data by species is shown in Table 3. Of 274 original plantings, 178 (65%) have survived and 155 (57%) are healthy. Of the surviving plants, 152 (55%) are over 24" in height. So far the project meets neither the woodland survival standard nor the height standard.

Pole cuttings and additional plantings were performed in December of this year. Heavy rains drowned many of the plantings and cuttings. Additional planting of 20 oaks and 50 cotton woods is scheduled for December, 1993 to increase woodland survival.

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ZENTNER